This module aims to familiarize observers with tuna pole and line vessels, fishing gear and fishing operations as these will be used daily in their routine work.

Trainee performance is evaluated against the following agreed IOTC ROS competency standards:

- Candidate recognises the basic layout of pole-and-line vessels.
- Candidate is familiar with working and observation areas and common fishing operational scenarios for the pole-and-line fisheries.

Achieving these standard is demonstrated by the candidate capacity to:

✓ demonstrate working knowledge of the structure of a pole-and-line vessel;

✓ recognising (from photos or drawings) working and observation areas on pole-and-line vessels;

✓ be acquainted with the different components of the pelagic pole-and-line tuna and bait fishing gear;

✓ demonstrate knowledge of general procedures in pole-and-line tuna and bait fishing operations (setting, hauling, processing).;

✓ be able to identify distinct processing and storing methods used.

P&L fishing operations are divided into three main activities:

1. effort spent to acquire live bait;
2. searching operations to find fish; and
3. actual poling operations.

With few exceptions, most tropical P&L operations in the IOTC area use live bait to attract schools of fish and incite them into a feeding response, and considerable effort is spent in sourcing live bait. The vessel may itself become involved with catching live bait using various techniques or may fish in association with other vessels that focus on collecting live bait and transfer bait to the P&L vessel. Frozen dead bait is sometimes used, but not considered as effective as live bait. Vessels targeting albacore tuna in more temperate areas may use frozen bait.

A second phase of the operations is searching for or inciting fish into a feeding frenzy, followed by actual poling activity. The two main means to find fish are either

1. target fish in association with a fish aggregation device (FAD); or
2. search for free swimming shoals.

The composition of baitfish species that the P&L fisheries use depends on the target tuna species and the location of the fishery:

- higher latitude pole-and-line fisheries that target the temperate tuna species (albacore and bluefin tunas) generally harvest a small number of hardy baitfish species often caught with a small pelagic purse seine net.

- tropical fisheries targeting skipjack and yellowfin tuna rely on a larger assortment of nearshore and reef-associated species that are often delicate and difficult to maintain in captivity. In these regions over 15 useable species can be caught at a time, but in most the catch is normally dominated by fewer than five species.

A variety of net types are used to collect baitfish, both by the P&L vessels themselves and by other fisheries supplying live baitfish to P&L operations.

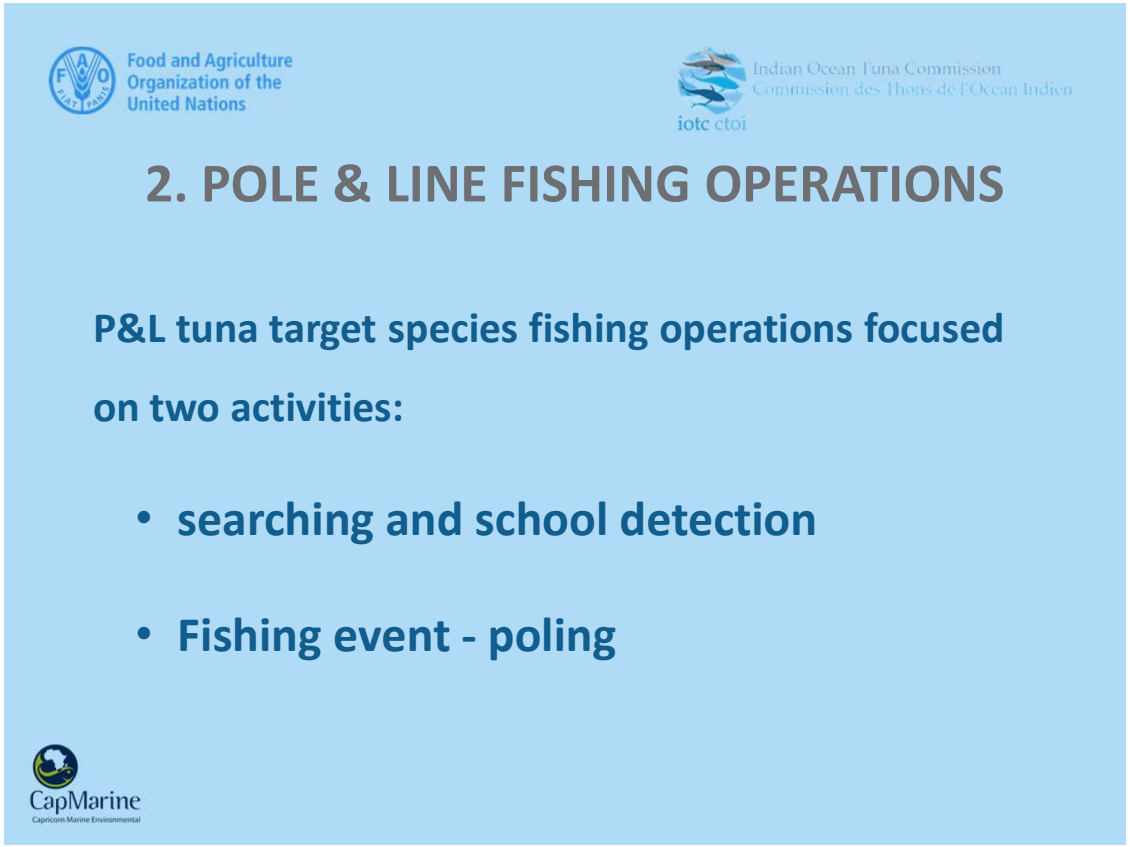
Baiting operations can be conducted during:

- **Daytime** (the most common), using beach seine or surround nets and drive-in nets are usually operated during daylight.
- **Night-time,** where the use of artificial bait-attraction lights is needed. Liftnets are an example of nets often used at night.

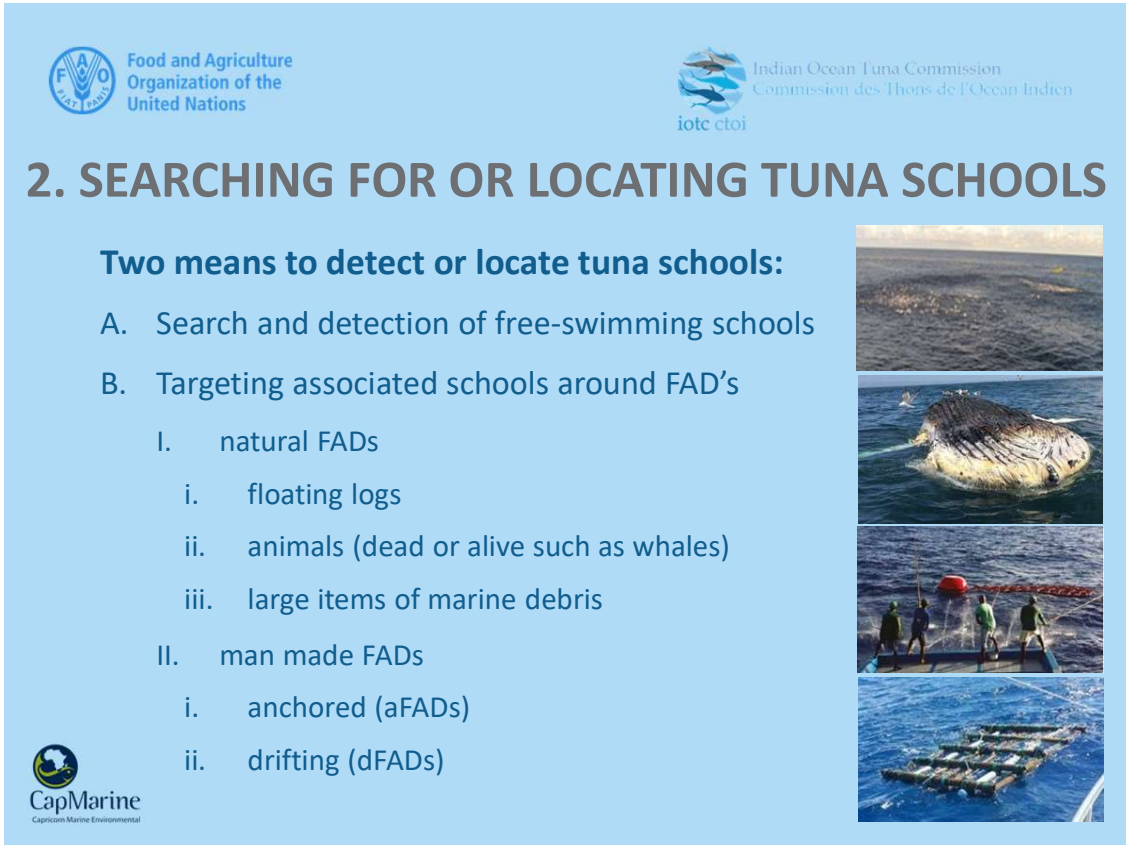
The type of net used and whether it is hauled in the day or at night depends on several factors:

- depth of the water
- bottom type (smooth or rough)
- behaviour of targeted baitfish species

Observers will be expected to collect information on bait fishing operations (time, position, depth), catch composition, and catch biometrics.



Pole-and-line tuna fishing operations (similar to purse seine) are divided into two main activities, searching for and locating fish and the actual fishing event.



Searching for fish often takes up most of the fishing operation time and can follow several strategies:

- the search and detection of free-swimming schools; or
- targeting associated schools around (FAD's) such as;
    - natural FADs (floating logs, dead animal, whales or other large items of floating marine debris)
    - man made anchored FADs; and
    - man made drifting FADs

A. Searching for free schools

Schools of tuna found in the open ocean and not associated with any structure or floating object are called "free" or "un-associated" schools. In fact, free-swimming schools are often chasing wild baitfish of some kind so their location is usually indicated by the presence of seabirds or by jumping and rolling tuna that are feeding on wild baitfish.

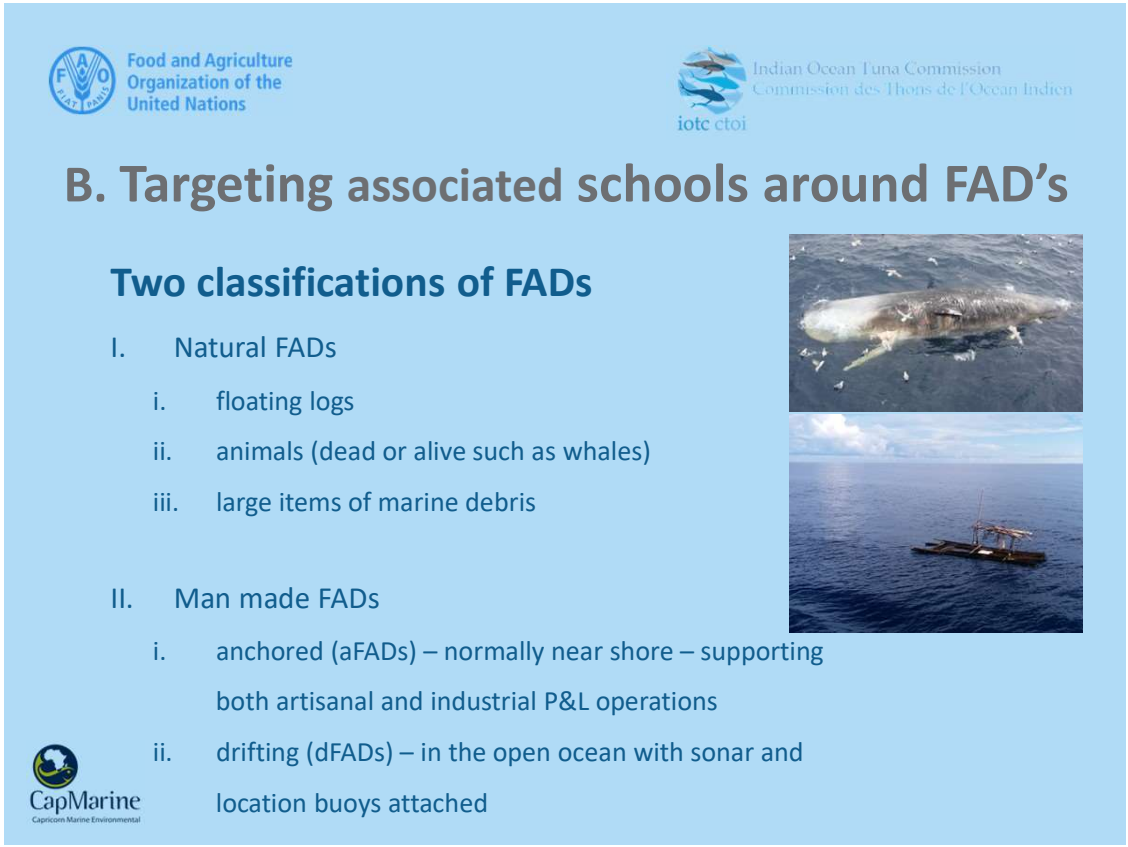
The search phase for free schools is an activity that can occupy the vessels crew for most of the daylight hours. Normally a number of search methods and or equipment are used in combination to detect schools of fish.

Spotters equipped with binoculars (of various range), search for indicators (cues) of fish in the vicinity of the vessel. These cues include,

- birds feeding;
- fish jumping;
- agitation on the sea surface (breezes); or
- sometimes the fish can be seen swimming below the surface.

Fish can also be detected on the sonar or an echo-sounder, or if first detected visually the depth of the school and direction it is moving can be determined using the sonar and echo-sounder.

Short-wave radars can also be used to detect birds working over fish and can also in some conditions detect fish splashing on the surface. This in turn can assist with visual detection.



Tunas are naturally attracted to any floating object in the open ocean collectively called *Fish Aggregation Devices* (FADs).

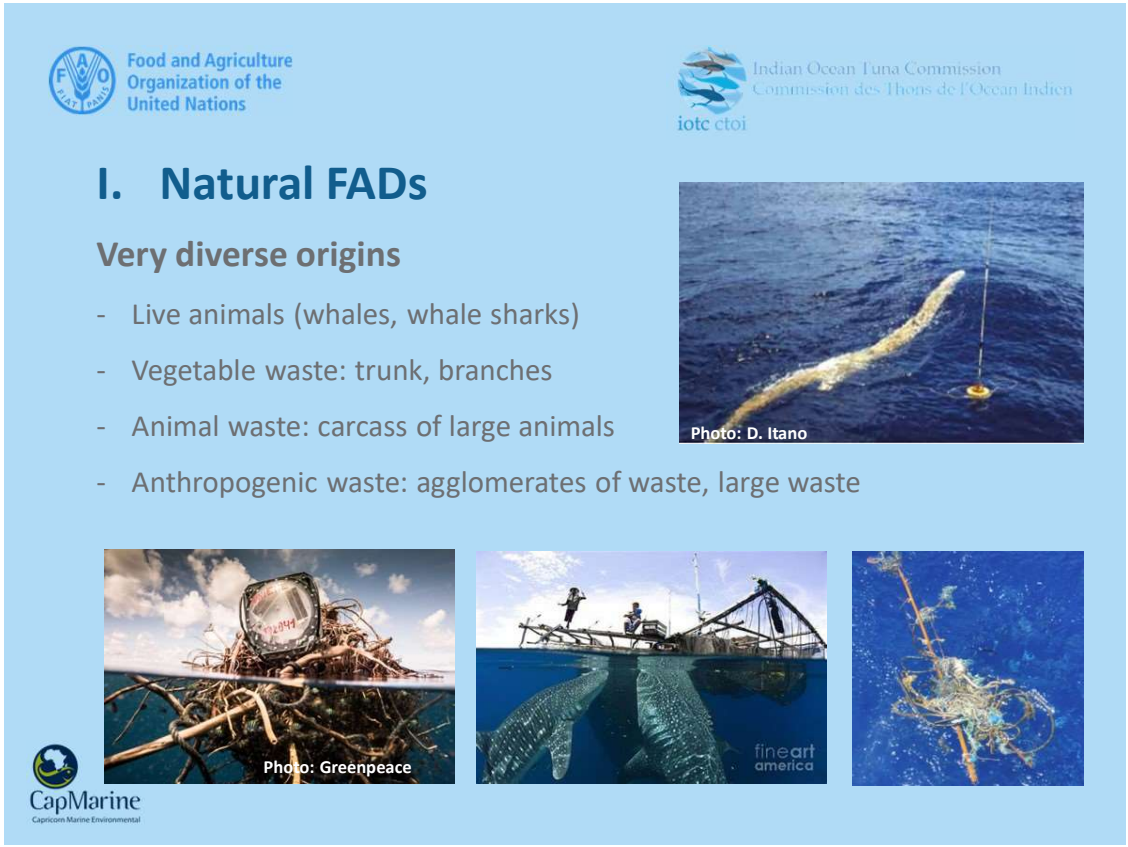
The IOTC defines **Fish aggregating devices (FADs) as,** anchored, drifting, floating, swimming or submerged object or group of objects, of any size, that has or has not been deployed, that is living or non-living, including but not limited to buoys, floats, netting, webbing, plastics, bamboo, logs, whales and whale sharks that fish may associate with.

These can be natural objects, such as a log or dead floating whale, or man made drifting objects, like a discarded wooden palette or a pile of discarded rope. Purpose made FADs are constructed from a combination of netting and rope attached to raft like structures made out of wood or bamboo.

FADs can also be broadly be divided into two main categories:

i. Anchored FADs (aFADs), that are anchored in one position and normally located inshore or in practical depths for anchoring. The advantage of an anchored FAD is that it can easily be located by artisanal or smaller semi commercial vessels with a limited range off-shore.

ii. Drifting FADs (dFADs) can be used off-shore and on high seas. Drifting FADs are usually fitted with a location device and may also have a sonar buoy to indicate presence of fish below it. Their main advantage is that a large number can be deployed at a time and monitored by vessel via satellite tracking.



Natural FADs are often attached to radio or satellite buoys, and some have sonar fish detection devices attached which transmit live information back to fishing vessels.

Skipjack, yellowfin and bigeye tuna sometimes associate with large, slow-moving animals such as whale sharks and manta rays. In the Indian Ocean, this kind of school is considered to be like a FAD-associated school. Fishing in close association with cetaceans, whale sharks or manta rays may be subject to restrictions, depending of country national legislation.

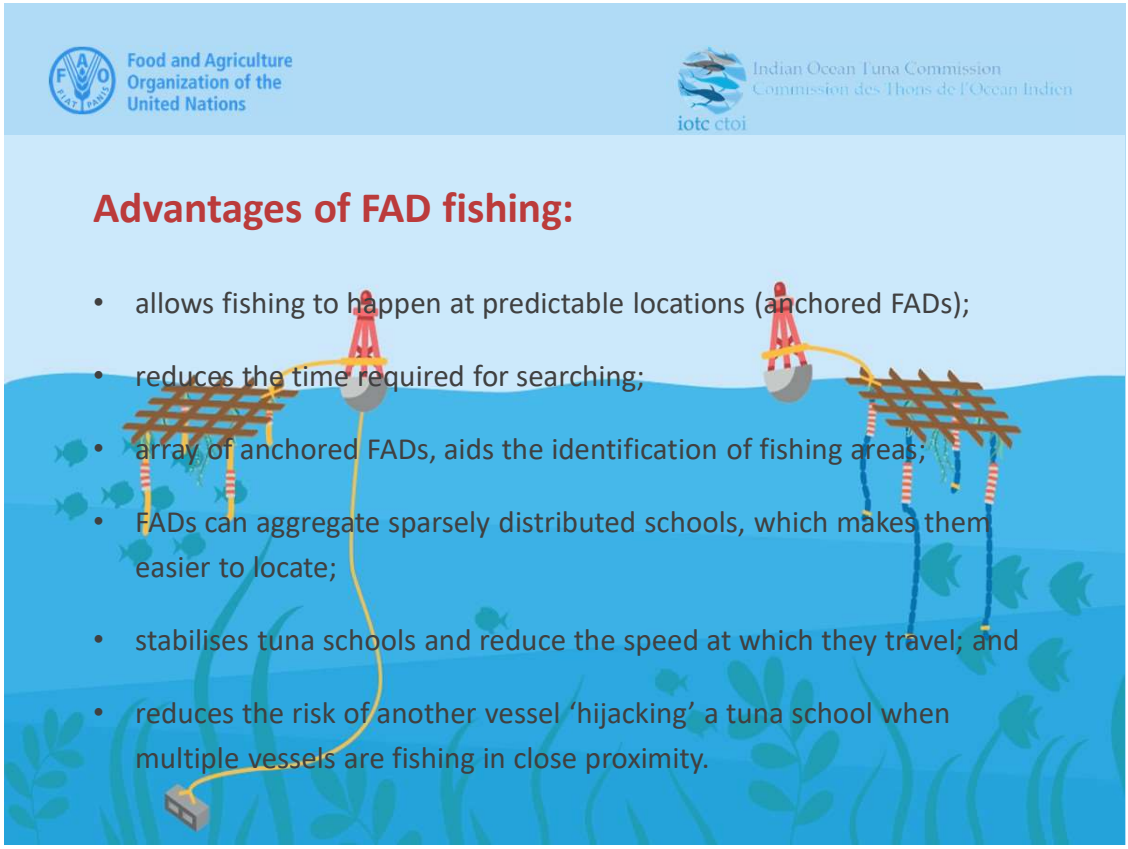
Observers should pay special attention when collecting information during this kind of fishing operation - possible impacts on animals during fishing operations (collisions, accidental catch, etc).

Some pole-and-line vessels utilize floating objects to achieve more productive fishing and some fisheries depend almost entirely on anchored FADs (aFADs). With large numbers of drifting FADs (dFADs) set by purse seine fleets in most tropical regions, they can drift into EEZs and thus provide fishing opportunities to coastal pole-and-line fishers. However, there are also environmental and fishery impacts associated with dFADs that must be addressed.

A dFADs usually consist of a surface raft or float and some underwater structure, such as old netting, rope, or natural material like palm fronds or leaves. A satellite buoy that reports information to the fishers like GPS position, drift speed, water temperature and battery state is usually attached to dFADs. In recent years, the use of satellite buoys equipped with an echo-sounder or sonar-like function (instrumented buoy) that gives an estimate of the aggregated biomass underneath the FAD have become popular with purse seine vessels. dFADS are commonly used in purse seine fisheries but much less frequently in pole-and-line fisheries. However, some pole and line vessels in West Africa also use dFADs.

Rafts or floats can be moored to the bottom and aggregate pelagic fish to assist fisheries. Deployment sites for aggregating tuna are often in depths exceeding 2,000 m. Anchored FADs have been set in many areas specifically to benefit pole-and-line fisheries, e.g., Indonesia and the Maldives. In the case of the Maldives, an anchored FAD-array has proven to be indispensable in increasing pole-and-line catch while decreasing vessel search time and carbon footprint.

All fishing gears need to be properly monitored and managed.



Advantages of fishing on FADS:

FADs are extensively used by both the purse seine fishery and pole-and-line vessels to reduce search time and achieve a higher catch rate per unit effort.

The association of tunas with aFADs is highly advantageous to near-shore industrial pole and line fisheries as it:

- allows fishing opportunities to be focused into a small number of predictable locations;
    - the known position of anchored FADs reduces the time required for searching;
    - the construction of an array of anchored FADs, aids the identification of promising fishing areas;
- aFADs can aggregate sparsely distributed schools, which makes them easier to spot than free swimming schools;
- stabilises tuna schools and reduce the speed at which they travel, making them comparatively easy to catch; and
- reduces the risk of another vessel 'hijacking' a tuna school when multiple vessels are fishing competitively in close proximity.

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3. TUNA FISHING OPERATIONS (POLING)

Fishing events

- For data recording: *a Fishing Event starts when the first line enters the water and ends when the last line comes out of the water*
- If the vessel stops fishing for a period of 10 minutes or more then that fishing event is ended - even if fishing restarts afterwards on the same school

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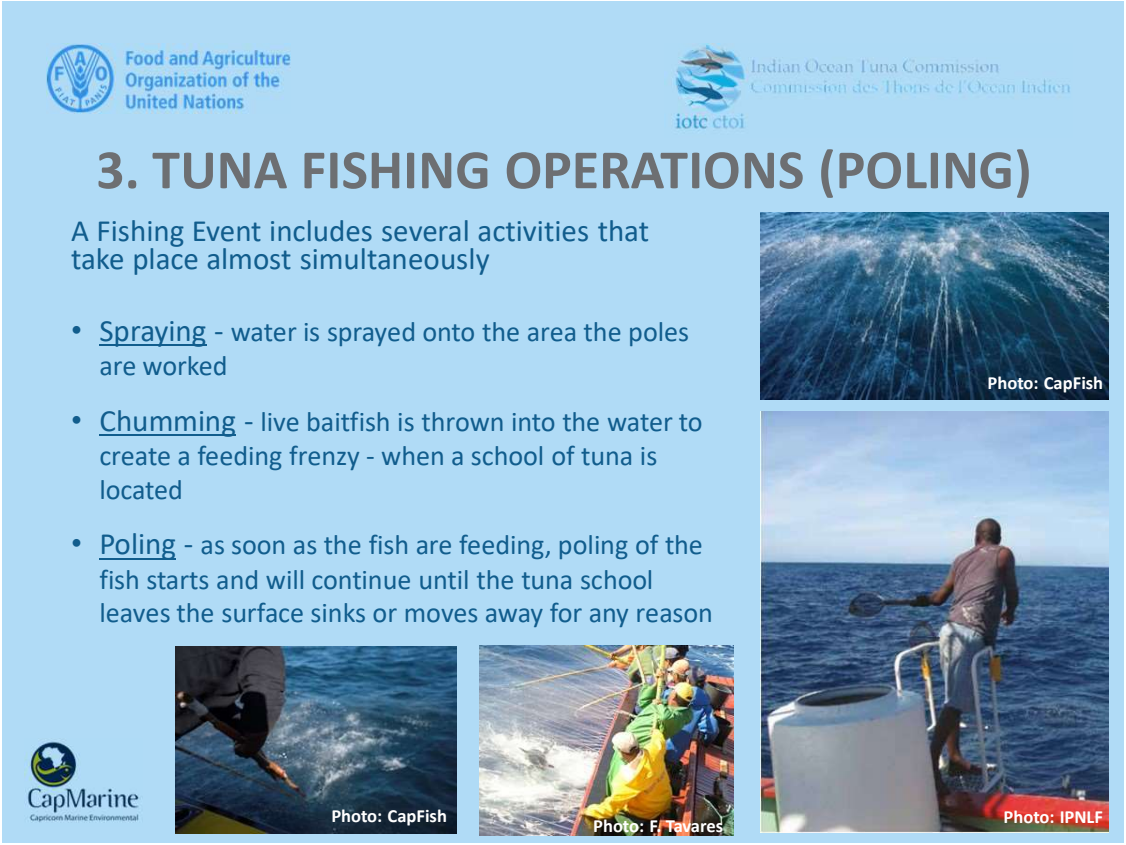
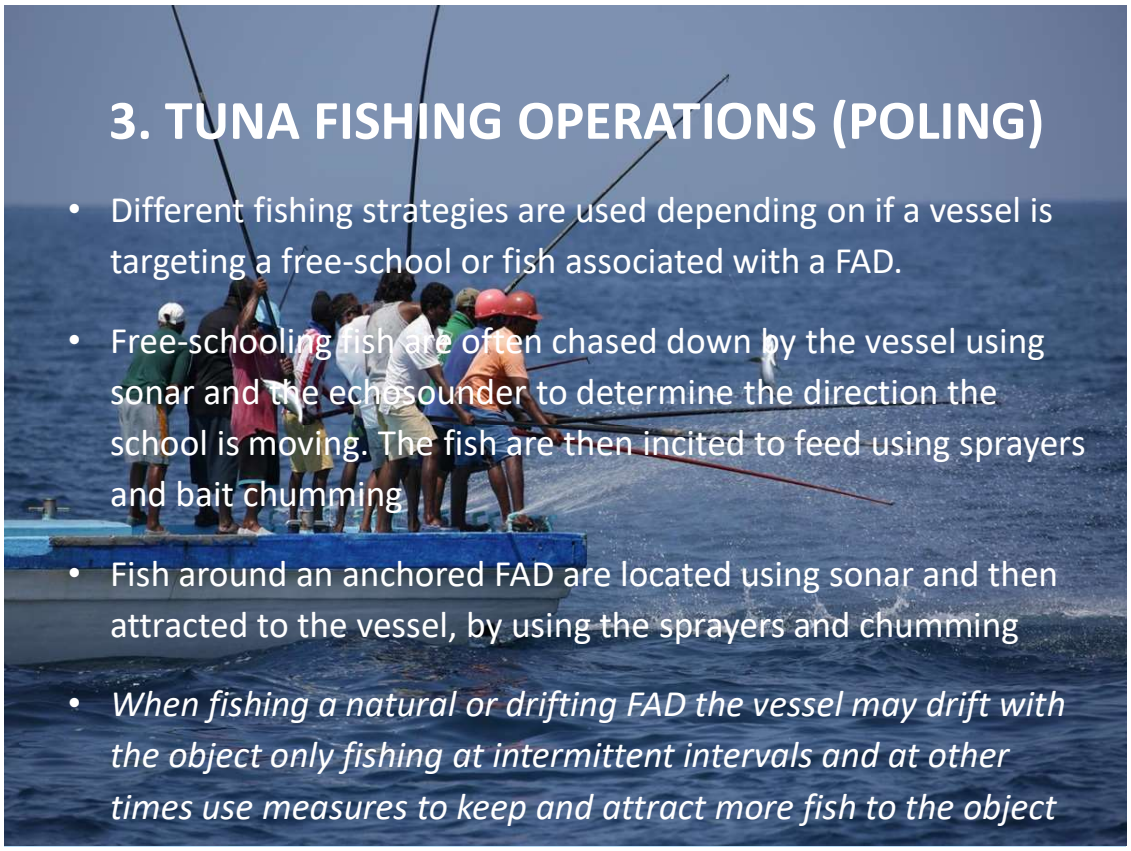


When a school of tuna is located the water sprayers are turned on, and live baitfish are scattered into the water (*chumming*), these both to attract the fish to the surface and create a feeding frenzy. The water sprayed also obscures the fishing line and the hook and further excite tuna, creating the illusion and sound of a large school of small fish near the surface.

Once the fish are feeding the fishermen will start poling fish out of the water from the area within the spray zone. Note: for data collection purposes *a Fishing Event* starts when the first line enters the water and ends when the last line comes out of the water



Fishing strategy when fishing on a free-swimming school

1. When a free-swimming school is sighted, the vessel will attempt to intercept the lead portion of the school at full speed.
2. The sonar is used to indicate whether tunas are present as well as the size of the fish and the density of the school, while the echo sounder indicates the depth of the school. Both devices are monitored closely throughout the operation.
3. As soon as the vessel is positioned above the school, the sprayers are turned on and chumming commences (or vice-versa). The combination of the spray agitating the surface and chum is used to get the fish into a feeding frenzy.
4. Fishing commences when the tuna are observed close to the surface taking the live bait. Live bait can be used on the hooks or feathered jigs can sometimes replace live bait when a feeding frenzy is induced.
5. Hooked fish are pulled from the water rapidly and landed on the vessel.

Fishing strategies when fishing on an associated school

1. At the arrival to the aFAD, the sonar or echo sounder are used to assist with school location and to determine the chumming strategy. Additionally, the activity of birds, visual cues, or trial and error can help locate the fish.
2. As a general rule, vessels approaching a FAD give way to a vessel already fishing the object, and thereafter take turns making drifts or approaches. Fishing can become crowded and contentious when vessels compete for the best area close to a FAD.
3. As soon as the vessel is positioned above the school, the sprayers are turned on and

chumming commences (or vice-versa).

4. Fishing commences when the tunas are observed close to the surface.
5. When fishing on a FAD, the initial catch normally consists of rainbow runner and dorado. These fish occupy the top layer and have to be landed before the yellowfin and skipjack are caught.
6. At times fishing may be halted before the school is exhausted.

Fishing drifting FADs (floating objects of natural or man-made origin)

The vessel follows the same strategy as fishing an anchored FAD but may also use several measures to keep and attract more fish to the FAD. These strategies include:

- fishing for short intensive periods;
- turning on water sprayers and chumming between fishing sessions;
- drifting day and night with the FAD; and
- turning on powerful deck lights at night.

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PRESERVATION OF THE CATCH

- When the fish lands on the vessel it is moved to storage holds by gravity, using a conveyor belt or manually
- The fish holds are normally located below deck and accessed from a central hatch
- With few exceptions the fish caught by P&L vessels are retained and landed whole


Photo: IPNLF


Photo: IPNLF


Photo: T. Kawamoto

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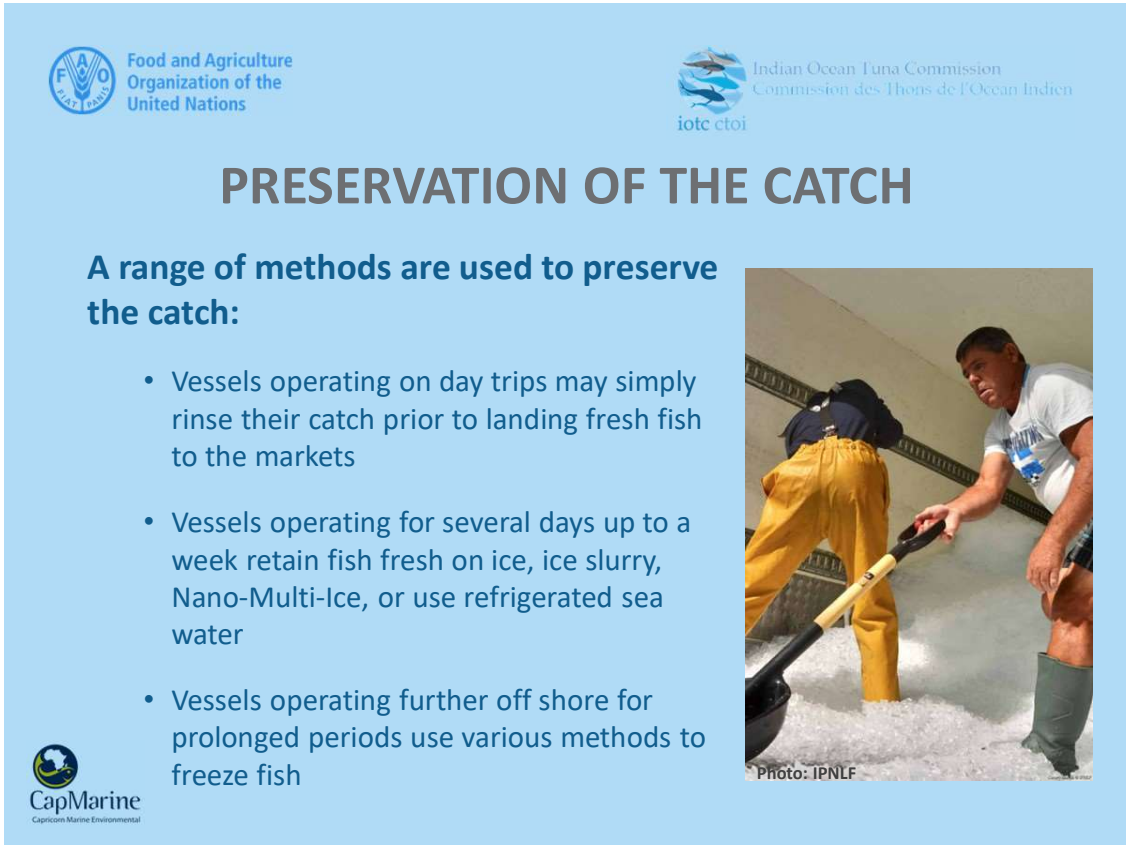
With few exceptions the fish caught by P&L vessels are retained and landed in a whole state.

Note that tuna have physiology that allows them to have a body temperature slightly higher than the seawater around them, therefore, to optimise the preservation and quality of tuna it is critically important to bring the fish temperature down as fast as possible to close to 0^{o}C. For vessels operating near shore and with a range of up to a maximum of 14-days, the most common means to preserve the catch uses ice where fish are packed directly into crushed ice. Fish holds may also have cooling compressors to assist in maintaining a temperature close to 0^{o}C.



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Refrigerated seawater

Refrigerated Seawater can be made in using cooling coils to reduce the temperature of seawater to 0°C. This method may also be used in conjunction with ice to make *ice brine* that rapidly bring the core temperature of tuna down.

Nano-Multi-Ice (NMI)

Nano-Multi-Ice (NMI) is a new technology that is currently being trialled in the Maldivian pole-and-line fishery. NMI is a very fine silky ice solution that is proving to be effective in bringing core temperatures of pole-and-line caught tuna down quite rapidly. It has several refrigerating benefits with substantial time savings (up to 20x faster cooling of fish), much improved fish quality, small size, light weight, extremely low refrigerant charge and relatively low power consumption.

Vessels operating for prolonged periods at sea are most likely to freeze their catch using various means and store the fish in a refrigerated hold. It is important to note that the freezing operation is separate from the actual refrigerated storage.

Brine Freezing

Freezer coils can chill a hyper-saline solution of seawater to well below the freezing point where the hyper-saline solution remains in a liquid state, but is cold enough to freeze the whole tuna. Whole tuna are transferred to the brine freezing wells that circulate the high-density brine at −18°C to −20°C. When the brine hold is filled with frozen tuna, the brine is pumped out and the fish kept in a dry, frozen state usually at a lower temperature — either in the same hold or sorted and transferred to other refrigerated holds.

Spray brine systems

Fish can be also be frozen in storage wells using a spray brine system where refrigerated brine solution is recirculated from the bottom of the well and sprayed over the top of the fish. The chilled brine runs by gravity over the fish, which freeze solid at the temperature of the brine (−18°C to −20°C). This system is adequate for canning-grade tuna.

Air blast dry freezers

Large Japanese P&L vessels use dry-blast freezing technology in blast freezing units to preserve high-quality frozen tuna at an ultra-low temperature (ULT) of −45°C to −60°C. The ULT frozen tuna are then transferred to the main hold and stored at −50°C for extended periods. Tuna frozen in this way maintain a suitable quality for sashimi, seared tuna and high-grade markets.

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ANY QUESTIONS?

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